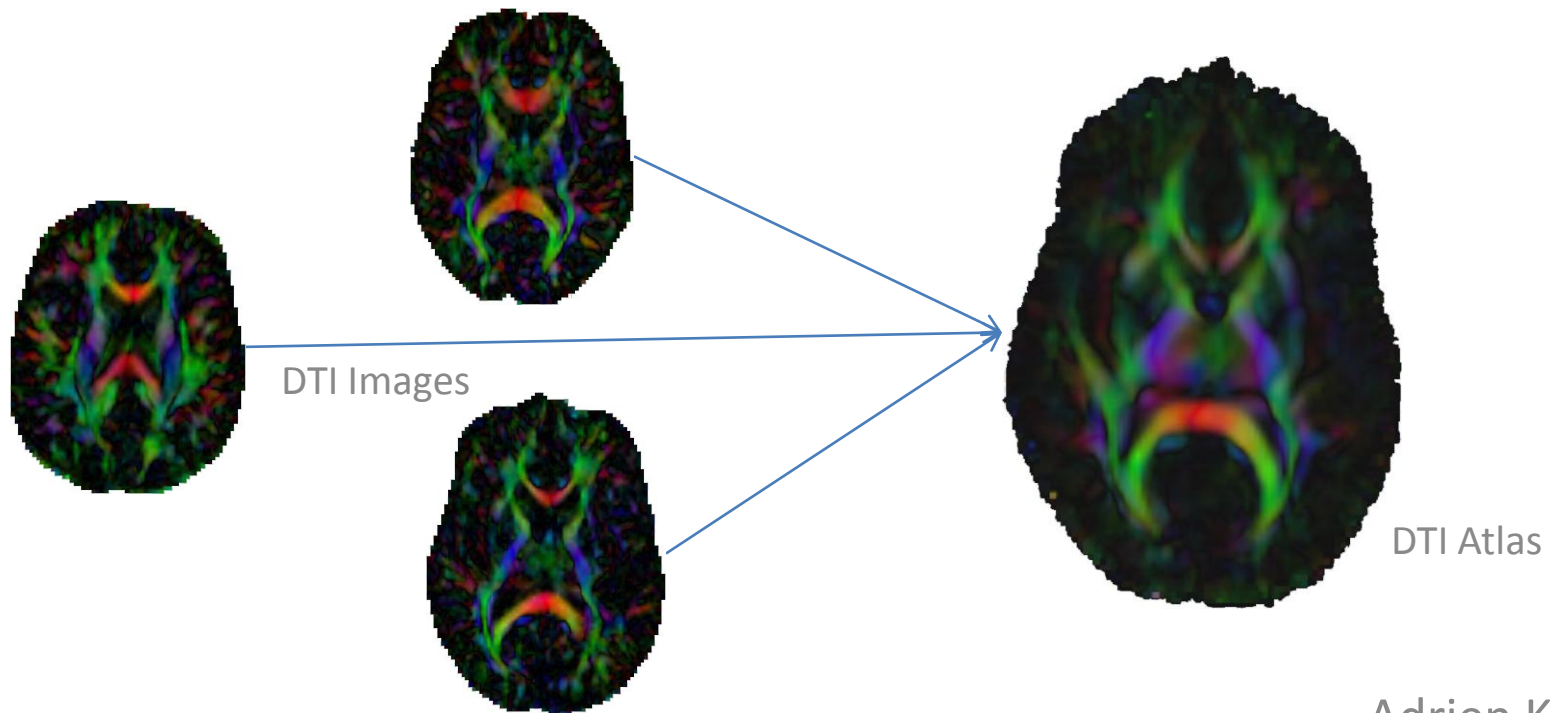


# DTIAtlasBuilder

A tool to create an atlas from several DTI images



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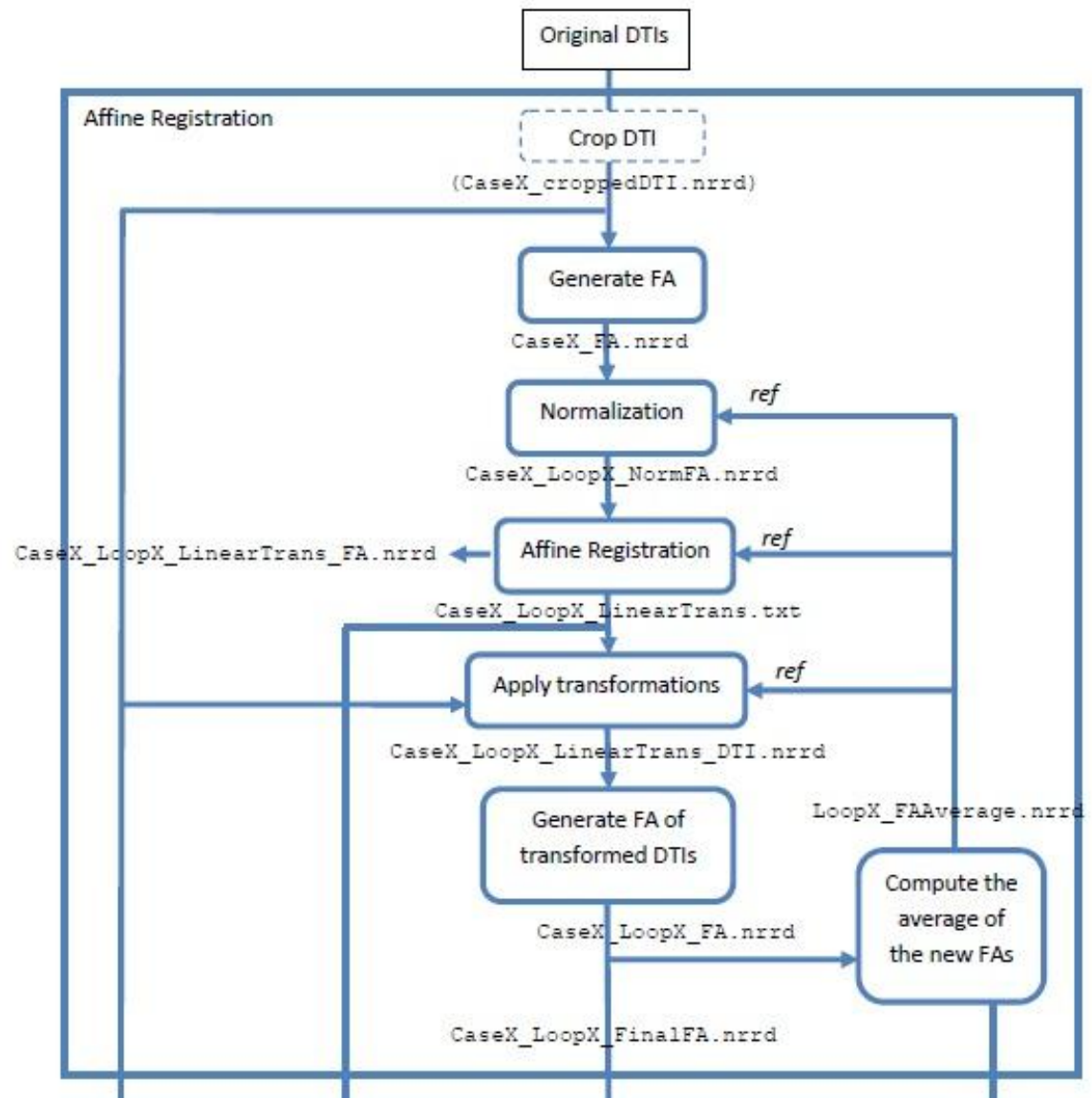
# Principle

- This program will allow you to create an Atlas image as an average of several registered DTI images. The registration will be done in two steps :
  - Affine Registration with BRAINSFit
  - Non Linear Registration with AtlasWerks
- A final step will apply the transformations to the DTI images so that the average can be computed.



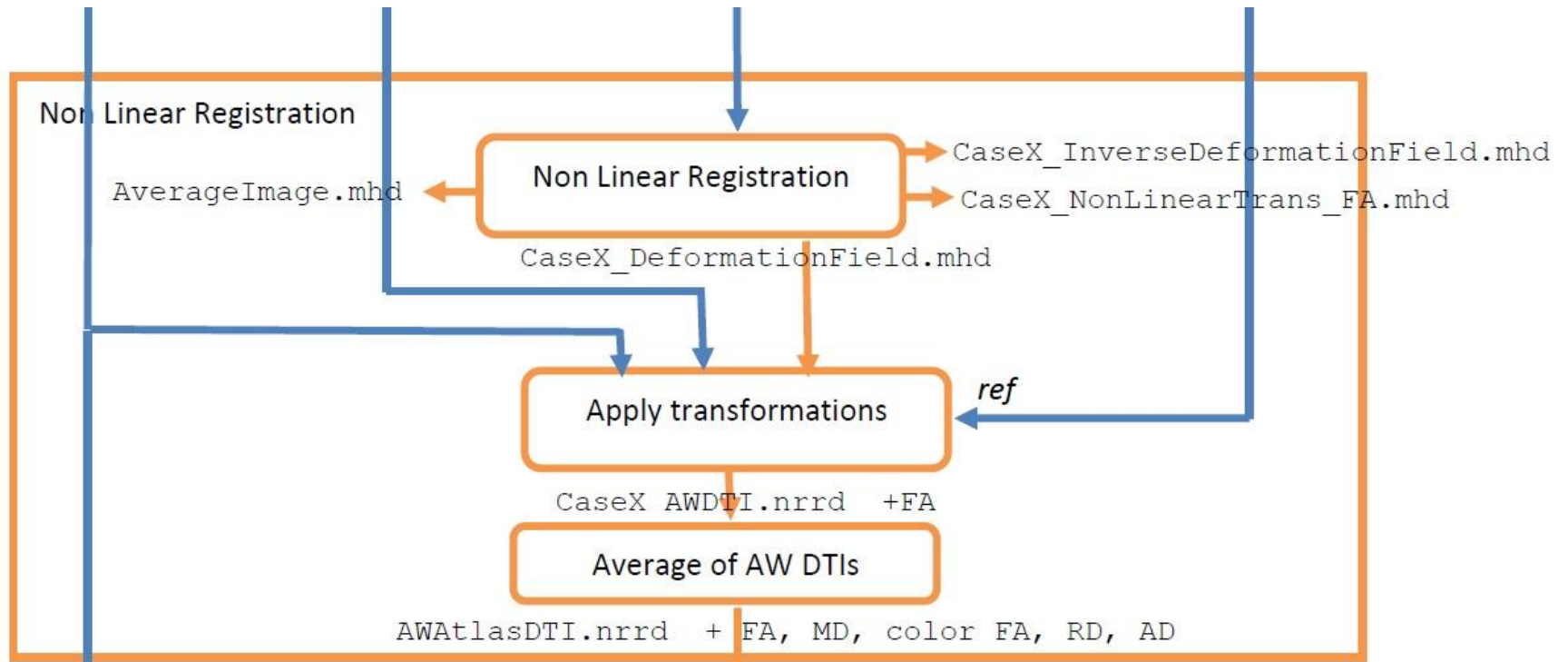
# Principle

- Affine Registration Pipeline
- The Affine Registration can be done in several loops. At each loop, the normalization and the registration will be done with a new reference, to improve the quality. The reference is the first case or a template you gave for the first loop, and then an average computed at the end of the loop.



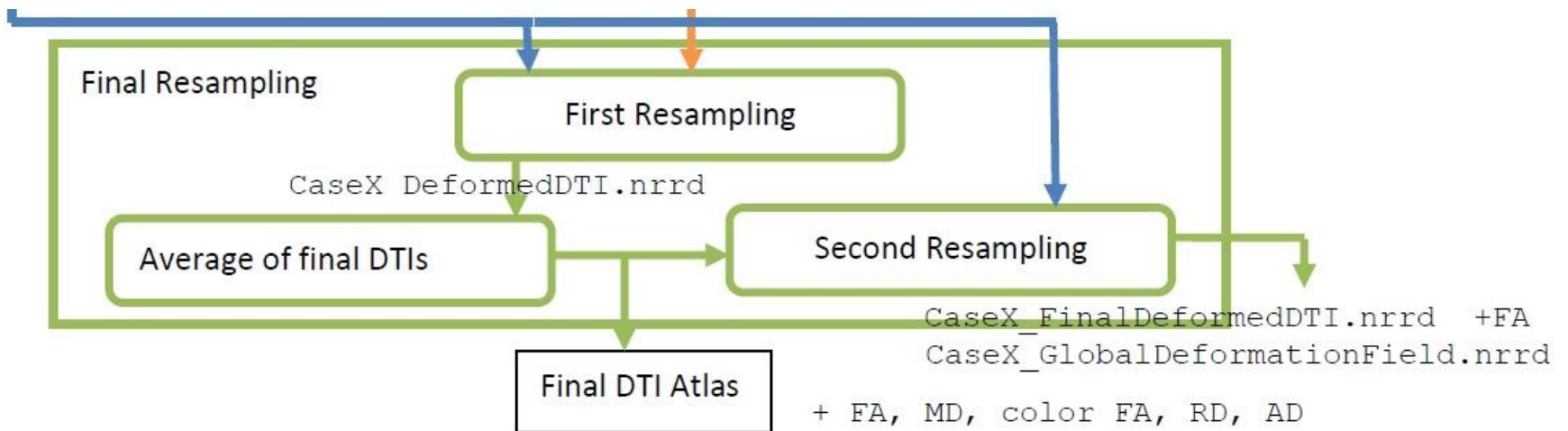
# Principle

- AtlasBuilding Pipeline : Non Linear Registration

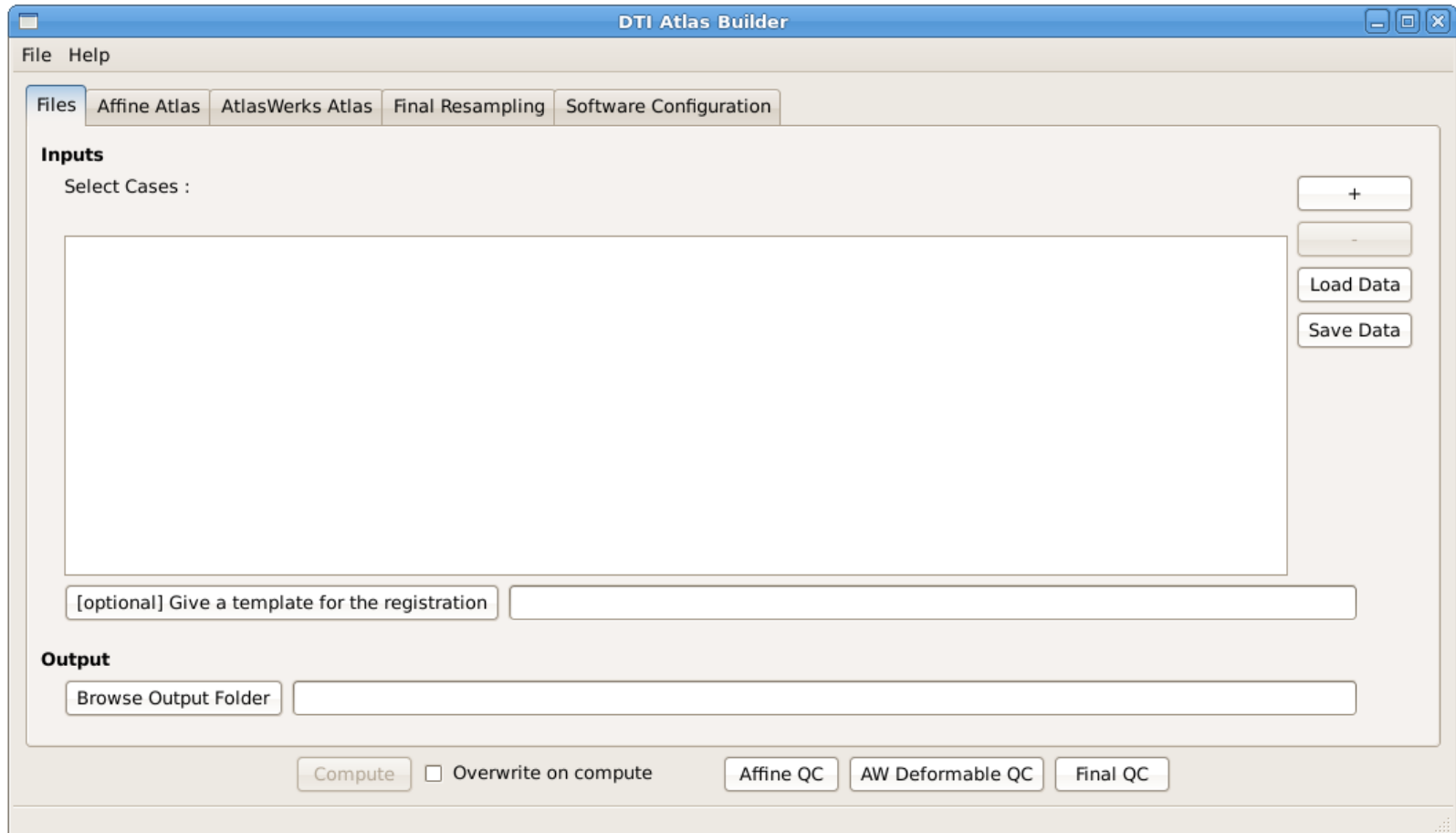


# Principle

- Final Resampling Pipeline

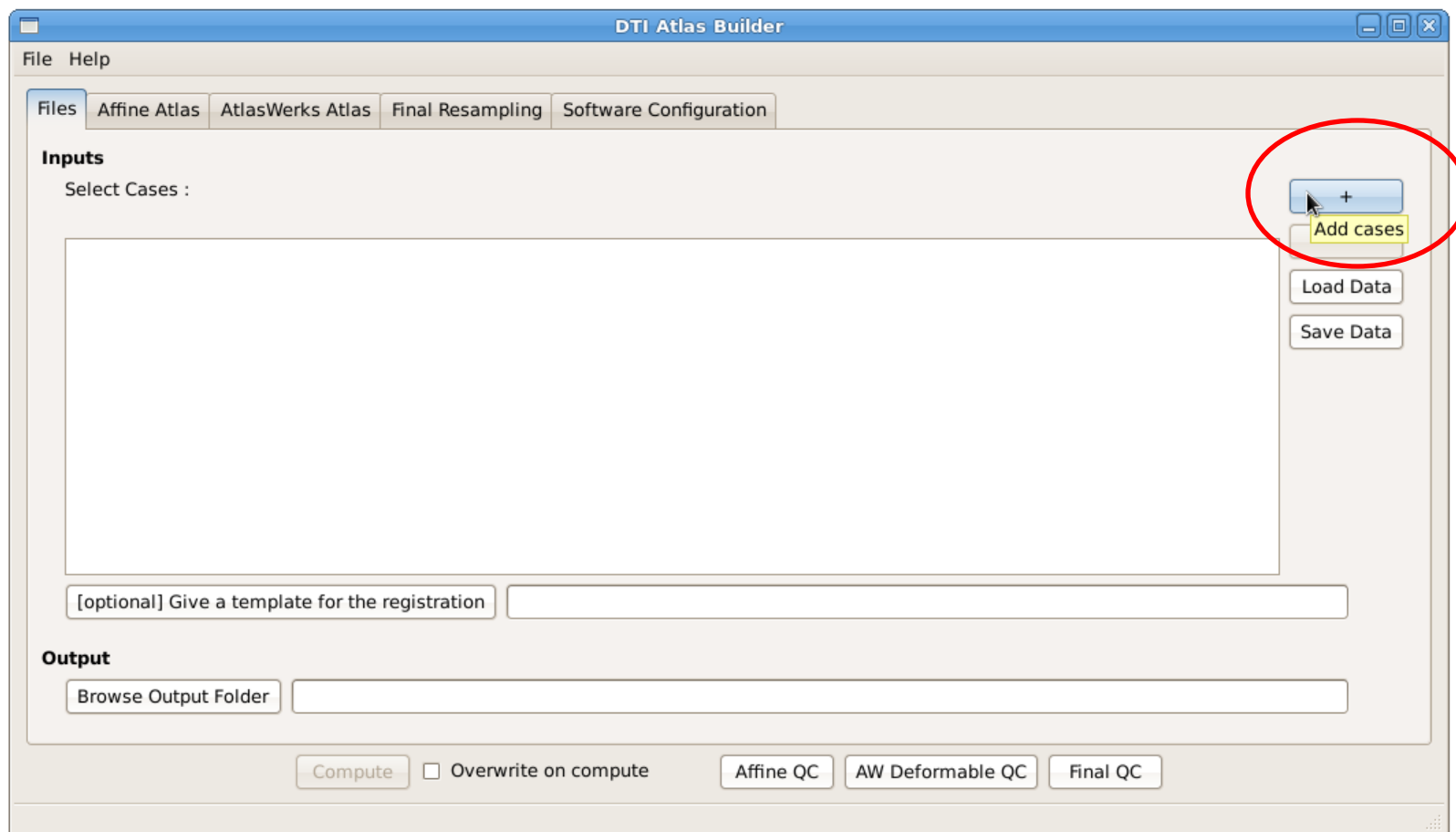


# GUI



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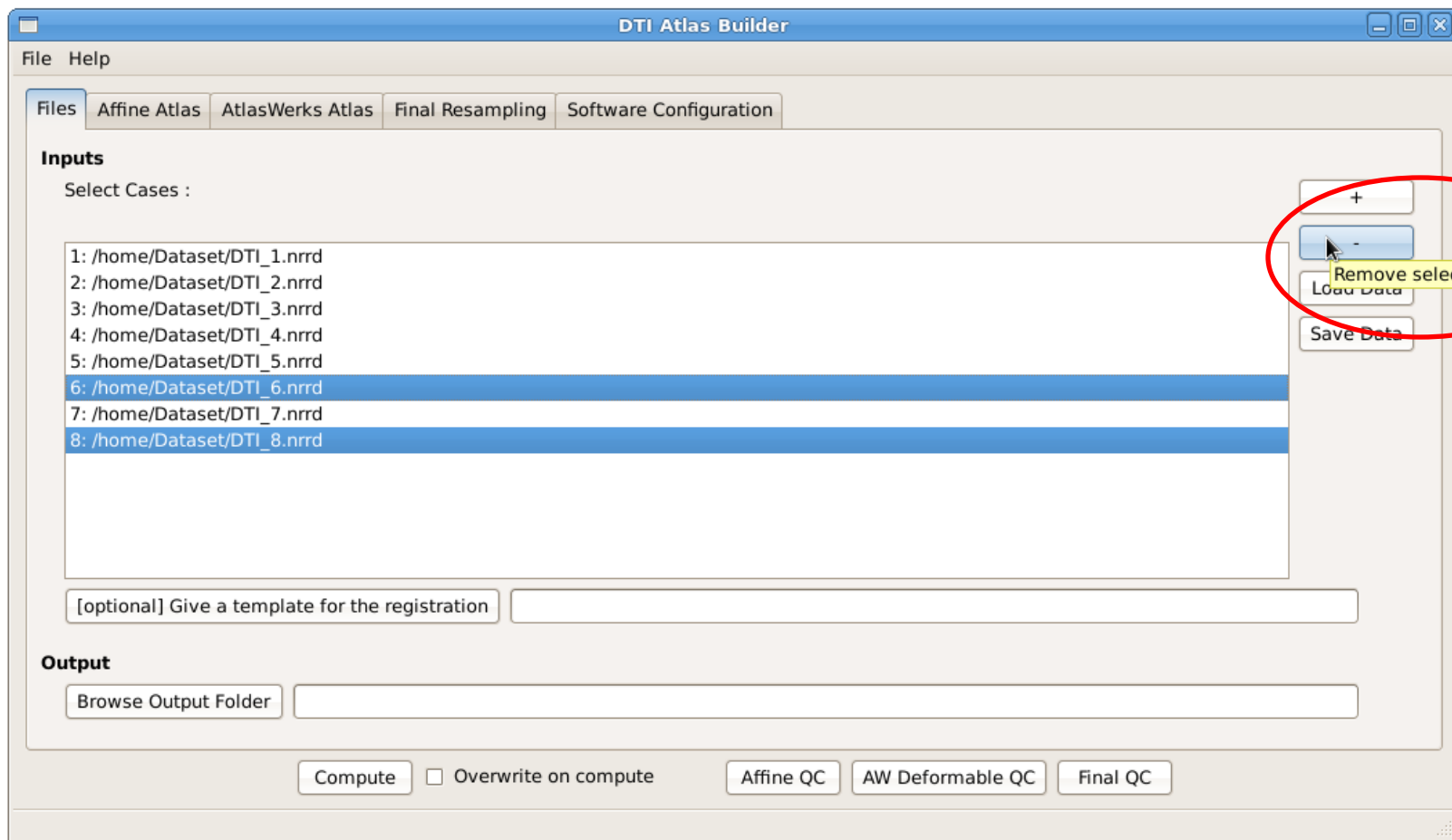
## Add DTI Images



- Clicking the '+' button will allow you to select several DTI images, and add it to the central Cases box

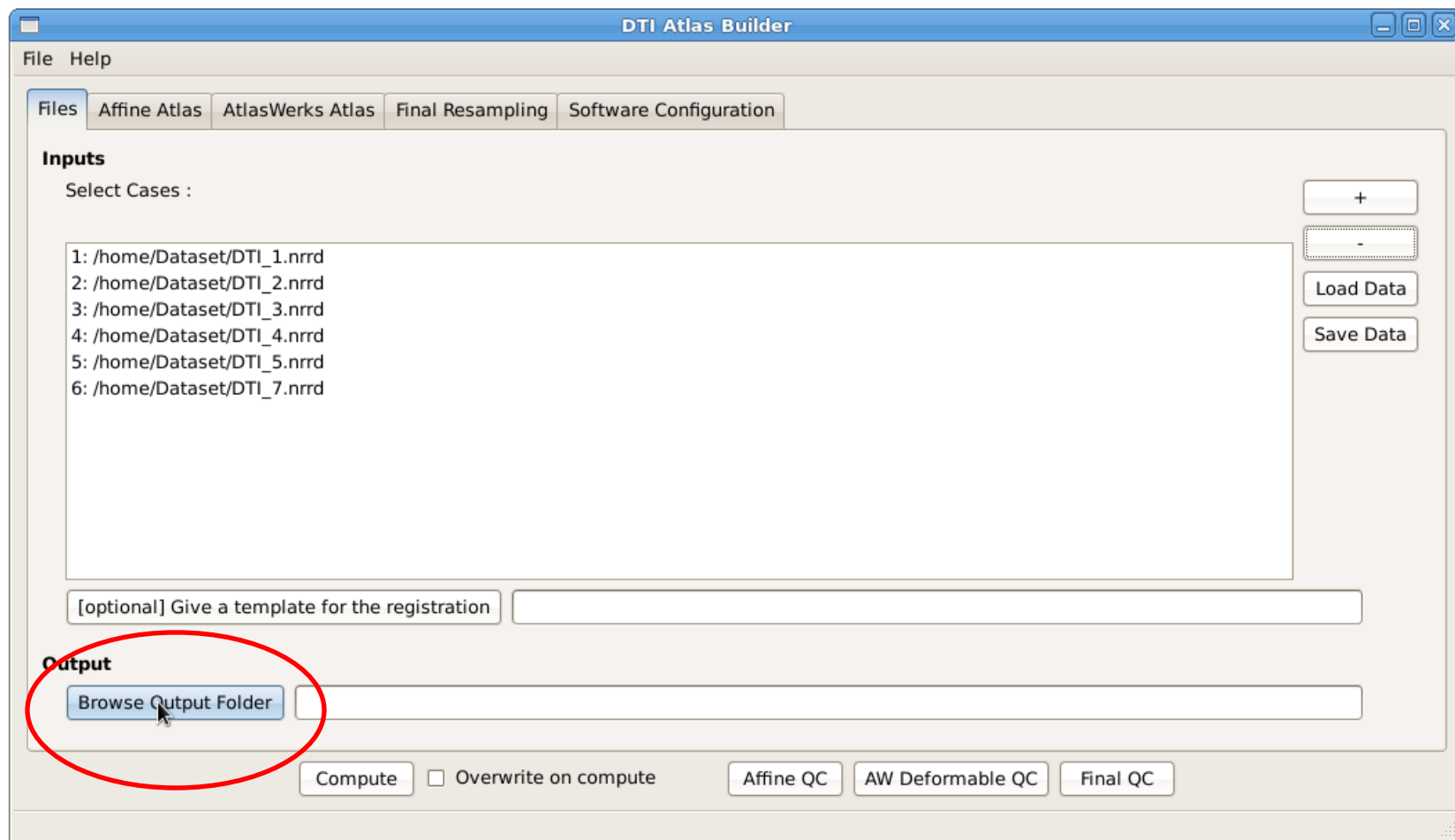


## Remove DTI Images



- After having selected some images, you can remove them from the central Cases box by clicking the '-' button

## Give an output folder



- You need to give an output folder: A folder named "DTIAtlas" will be created in your output folder, and all the files generated by the program will be put in it (Data organization on slide 33)

# Optional : Give a FA Template

- As an option, you can give a scalar image (FA) as a template that will be used as reference for the affine registration with BRAINSFit in the first Loop.
- If you do not give a template, the reference for the registration will be the first case, and then the FA average if there are loops.



# Basic Use

## Optional : Give a FA Template

DTI Atlas Builder

File Help

Files Affine Atlas AtlasWerks Atlas Final Resampling Software Configuration

**Inputs**

Select Cases :

1: /home/Dataset/DTI\_1.nrrd  
2: /home/Dataset/DTI\_2.nrrd  
3: /home/Dataset/DTI\_3.nrrd  
4: /home/Dataset/DTI\_4.nrrd  
5: /home/Dataset/DTI\_5.nrrd  
6: /home/Dataset/DTI\_7.nrrd

[optional] Give a template for the registration  
Use of a FA Template

**Output**

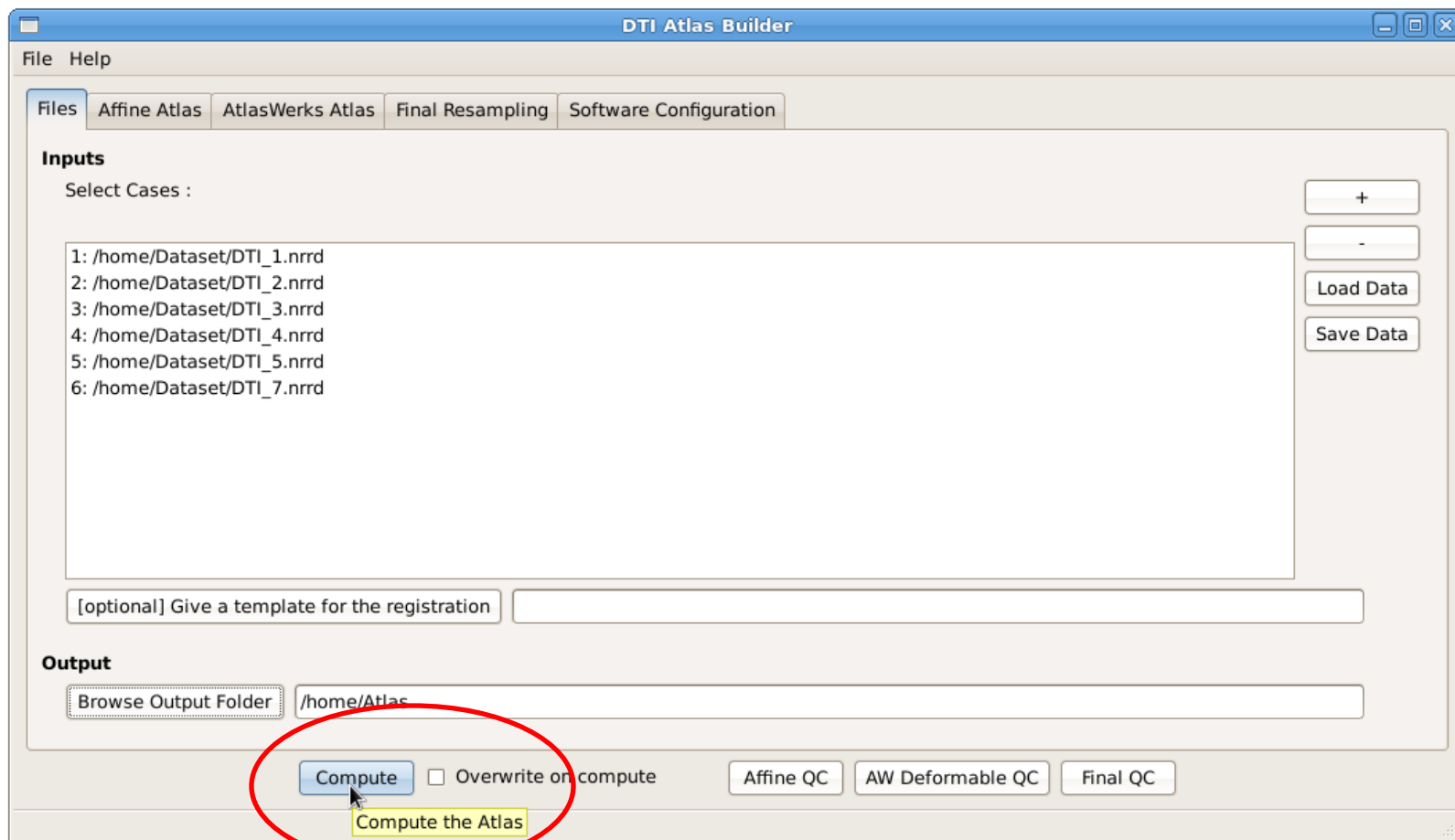
Browse Output Folder /home/Atlas

Compute ☐ Overwrite on compute Affine QC AW Deformable QC Final QC



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# Compute the Atlas



- When you added cases and gave an output folder, you can compute the Atlas by clicking the "Compute" button. It will test the existence and type of the files and the folders and tell you if some files are not images or DTIs.

# Options

# Overwriting

DTI Atlas Builder

File Help

Files Affine Atlas AtlasWerks Atlas Final Resampling Software Configuration

**Inputs**

Select Cases :

1: /home/Dataset/DTI\_1.nrrd  
2: /home/Dataset/DTI\_2.nrrd  
3: /home/Dataset/DTI\_3.nrrd  
4: /home/Dataset/DTI\_4.nrrd  
5: /home/Dataset/DTI\_5.nrrd  
6: /home/Dataset/DTI\_7.nrrd

[optional] Give a template for the registration

**Output**

Browse Output Folder /home/Atlas

Compute ☒ Overwrite on compute Affine QC AW Deformable QC Final QC



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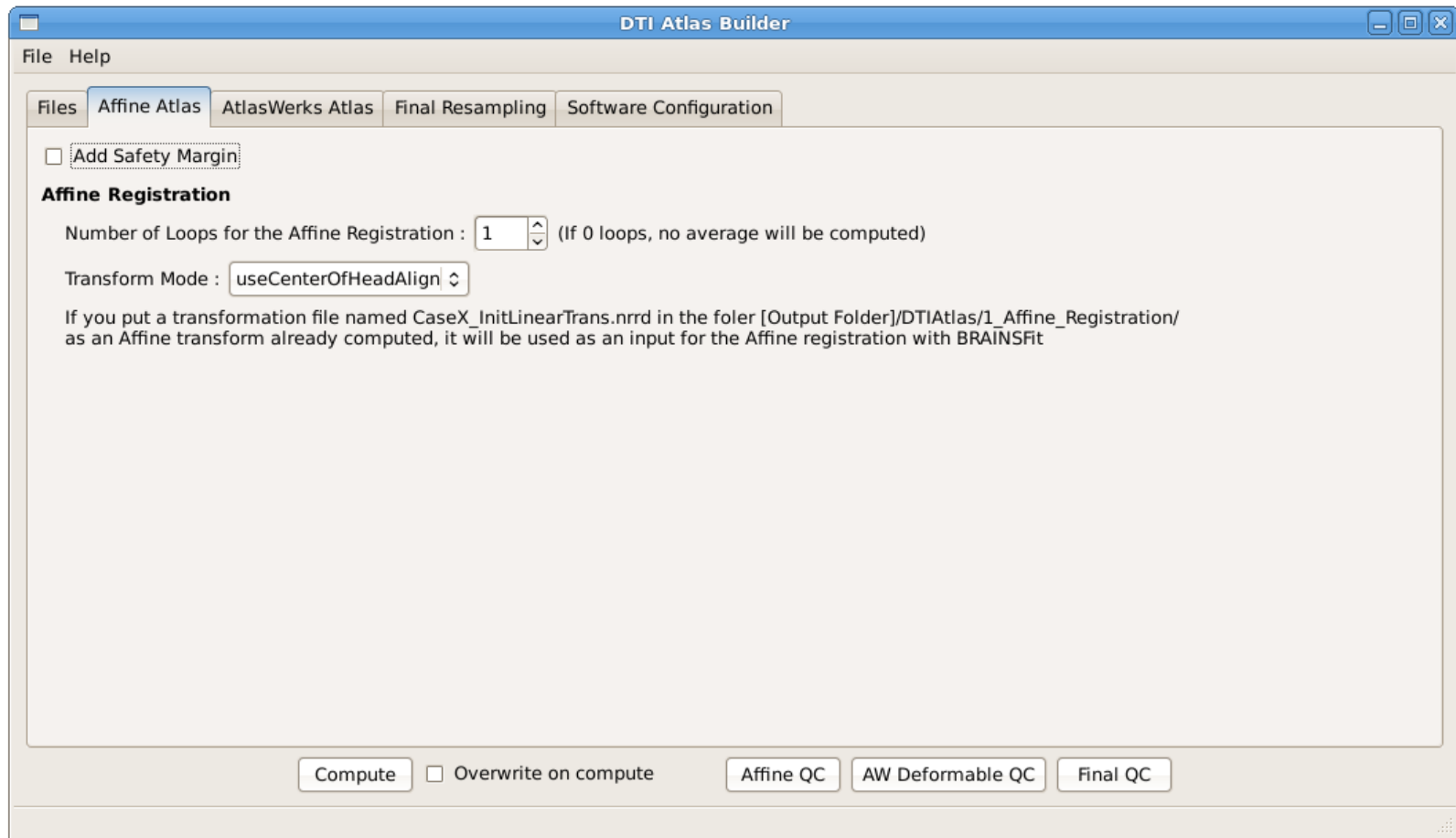
- The "Overwrite" option will allow you write the images anyway, over existing images if they were computed already.

## Affine Atlas

- Safety Margin : Add 2 voxels at each side of the volume
- Initial Affine Transform : If you put a transformation file named `CaseX_InitLinearTrans.nrrd` in the folder [Output Folder]/DTIAtlas/1\_Affine\_Registration/ as an affine transform already computed, it will be used as an input for the Affine registration with BRAINSFit



## Affine Atlas



The screenshot shows the 'DTI Atlas Builder' application window. The 'Affine Atlas' tab is selected, showing options for affine registration. A checkbox for 'Add Safety Margin' is present. The 'Affine Registration' section includes a 'Number of Loops for the Affine Registration' set to 1, a 'Transform Mode' dropdown set to 'useCenterOfHeadAlign', and a descriptive text block about using a pre-computed transformation file. At the bottom, there are buttons for 'Compute', 'Affine QC', 'AW Deformable QC', and 'Final QC', along with an 'Overwrite on compute' checkbox.

DTI Atlas Builder

File Help

Files Affine Atlas AtlasWerks Atlas Final Resampling Software Configuration

☐ Add Safety Margin

**Affine Registration**

Number of Loops for the Affine Registration : 1 (If 0 loops, no average will be computed)

Transform Mode : useCenterOfHeadAlign

If you put a transformation file named CaseX\_InitLinearTrans.nrrd in the folder [Output Folder]/DTIAtlas/1\_Affine\_Registration/ as an Affine transform already computed, it will be used as an input for the Affine registration with BRAINSFit

Compute ☐ Overwrite on compute Affine QC AW Deformable QC Final QC





## AtlasWerks Atlas

- The AtlasWerks Atlas is the Atlas computed from the affine registered images to get the deformation fields from the final images to the affine space.
- These deformation fields will be applied to the original DTIs which will be used to compute the first DTI average.
- You can choose the Scale Levels that you want for AtlasWerks and also the options for the Resampling and for the average compute.



# Options

# AtlasWerks Atlas

DTI Atlas Builder

File Help

Files Affine Atlas **AtlasWerks Atlas** Final Resampling Software Configuration

**AtlasWerks**

☒ Scale Level: 4 Nb Of Iterations: 150 Alpha: 1.0000 Beta: 1.0000 Gamma: 0.0001 Max. Perturbation: 0.0010

☒ Scale Level: 2 Nb Of Iterations: 120 Alpha: 1.0000 Beta: 1.0000 Gamma: 0.0010 Max. Perturbation: 0.0100

☒ Scale Level: 1 Nb Of Iterations: 100 Alpha: 0.1000 Beta: 0.1000 Gamma: 0.0100 Max. Perturbation: 0.1000

**Resampling Parameters**

Resampling Interpolation Algorithm: Linear

Tensor Interpolation: Log Euclidean

Tensor Transformation: PPD

**Average computation**

DTI Average Statistics Method: Log Euclidean

Compute ☐ Overwrite on compute Affine QC AW Deformable QC Final QC



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## Final Resampling

The screenshot shows the 'DTI Atlas Builder' window with the 'Final Resampling' tab selected. The interface includes a menu bar with 'File' and 'Help'. Below the menu bar are tabs for 'Files', 'Affine Atlas', 'AtlasWerks Atlas', 'Final Resampling', and 'Software Configuration'. The 'DTI-Reg' section contains the following settings:

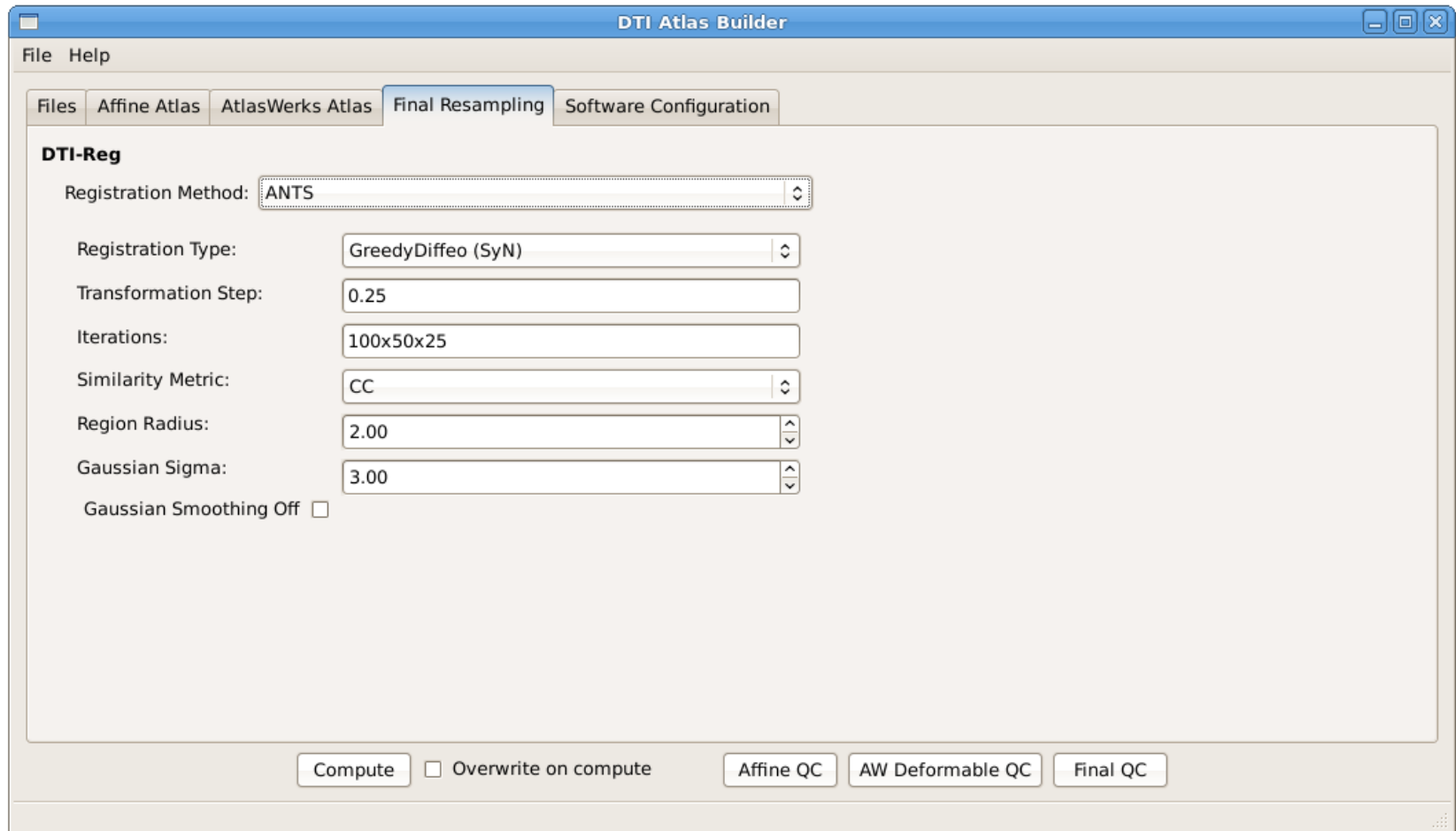
- Registration Method: BRAINS
- Registration Type: LogDemons
- Transform Mode: Use computed affine transform
- Smooth Deformation Field Sigma: 1.00
- Number Of Pyramid Levels: 5
- Number Of Iterations for the Pyramid Levels: 300,50,30,20,15

At the bottom of the window, there are buttons for 'Compute', 'Affine QC', 'AW Deformable QC', and 'Final QC'. A checkbox for 'Overwrite on compute' is also present.



- The Final Resampling will be done with DTI-Reg, it will create the global deformation fields from the final images to the original space. You can use either BRAINS or ANTS, and you can also choose your options.

## Final Resampling



The screenshot shows the 'DTI Atlas Builder' application window. The 'Final Resampling' tab is selected, showing various registration and resampling parameters. The 'DTI-Reg' section includes a 'Registration Method' dropdown set to 'ANTS', a 'Registration Type' dropdown set to 'GreedyDiffeo (SyN)', a 'Transformation Step' text box with '0.25', an 'Iterations' text box with '100x50x25', a 'Similarity Metric' dropdown set to 'CC', a 'Region Radius' dropdown set to '2.00', a 'Gaussian Sigma' dropdown set to '3.00', and a 'Gaussian Smoothing Off' checkbox which is unchecked. At the bottom, there are buttons for 'Compute', 'Affine QC', 'AW Deformable QC', and 'Final QC', along with an 'Overwrite on compute' checkbox.

DTI Atlas Builder

File Help

Files Affine Atlas AtlasWerks Atlas Final Resampling Software Configuration

**DTI-Reg**

Registration Method: ANTS

Registration Type: GreedyDiffeo (SyN)

Transformation Step: 0.25

Iterations: 100x50x25

Similarity Metric: CC

Region Radius: 2.00

Gaussian Sigma: 3.00

Gaussian Smoothing Off ☐

Compute ☐ Overwrite on compute Affine QC AW Deformable QC Final QC



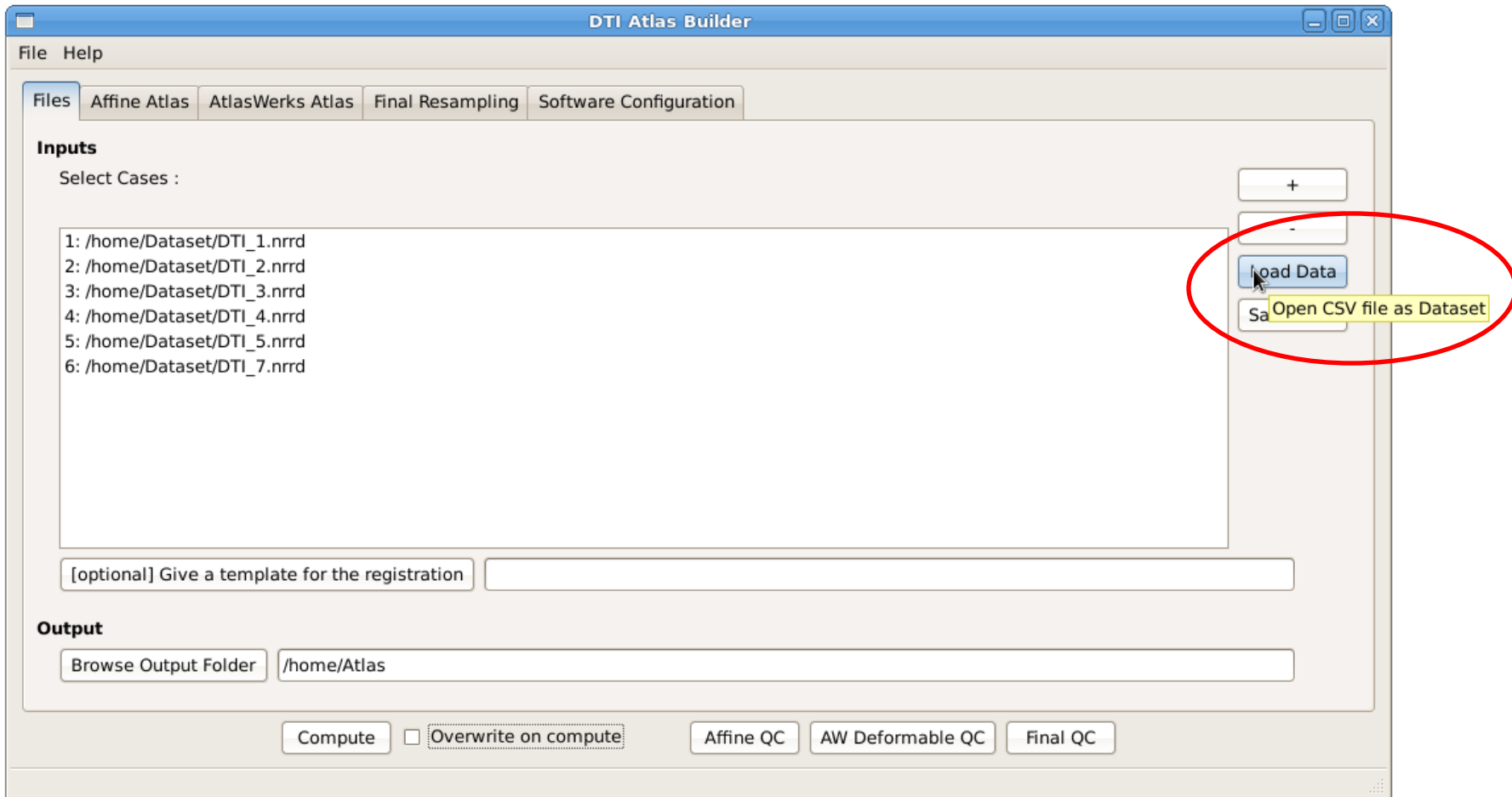
# Load and Save

- Save your parameters: In the « File » Menu, you can Save or Load a parameter file generated by the program. Do not change the parameter file manually, because it could be recognized by the program as a corrupt file and not be read.
- When you save the parameters, a .csv file with the dataset will automatically be created in the same directory than the parameter file.
- Auto save: When you push the « Compute » button, the program will automatically save a parameter file (`DTIAtlasBuilderParameters.txt`) and a .csv dataset file (`DTIAtlasBuilderDataset.csv`) in [Output Folder]/DTIAtlas.  
It will also save a .csv file with the paths to all the interesting files generated, in this same folder (`DTIAtlasBuilderResults.csv`).
- You can save your Dataset into a CSV file so you can load it and use it again later.
- You can also load a CSV file containing paths to a Dataset you saved before or you wrote yourself with this style:

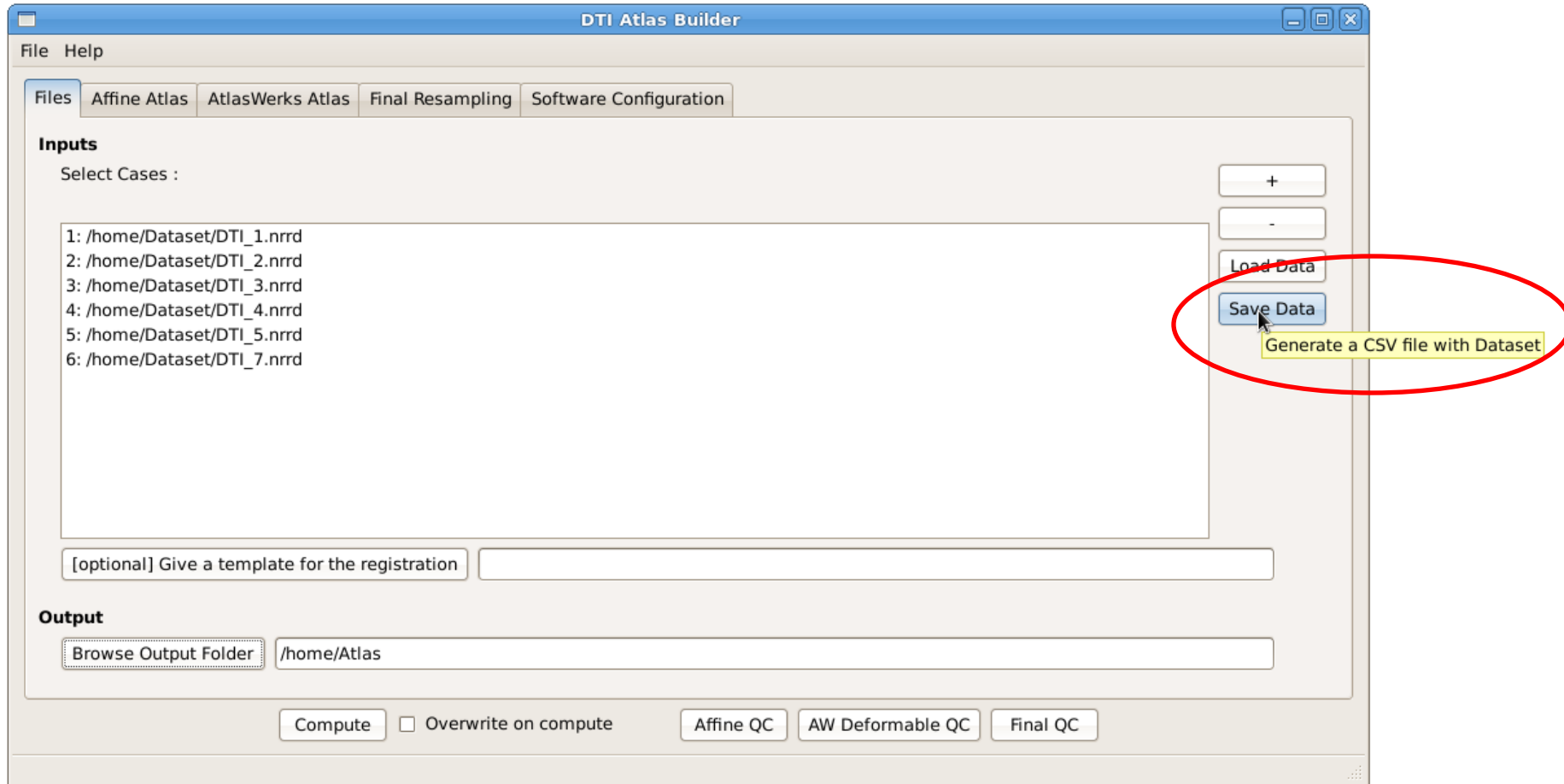
```
id,Original DTI Image
1,/home/Dataset/DTI_1.nrrd
2,/home/Dataset/DTI_2.nrrd
3,/home/Dataset/DTI_3.nrrd
4,/home/Dataset/DTI_4.nrrd
5,/home/Dataset/DTI_5.nrrd
6,/home/Dataset/DTI_6.nrrd
7,/home/Dataset/DTI_7.nrrd
8,/home/Dataset/DTI_8.nrrd
9,/home/Dataset/DTI_9.nrrd
...
...
...
```



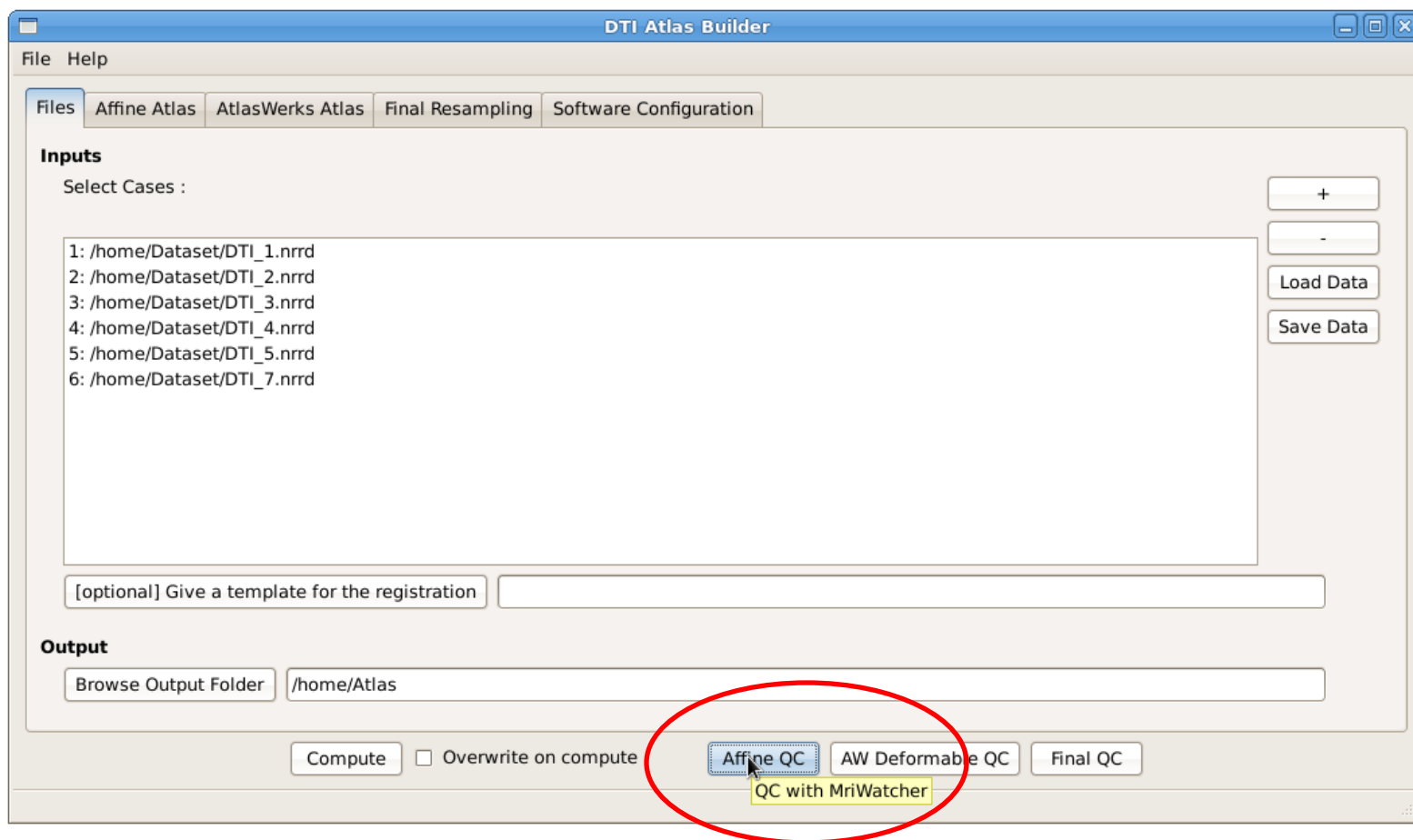
# Load and Save



# Load and Save



# Quality Control



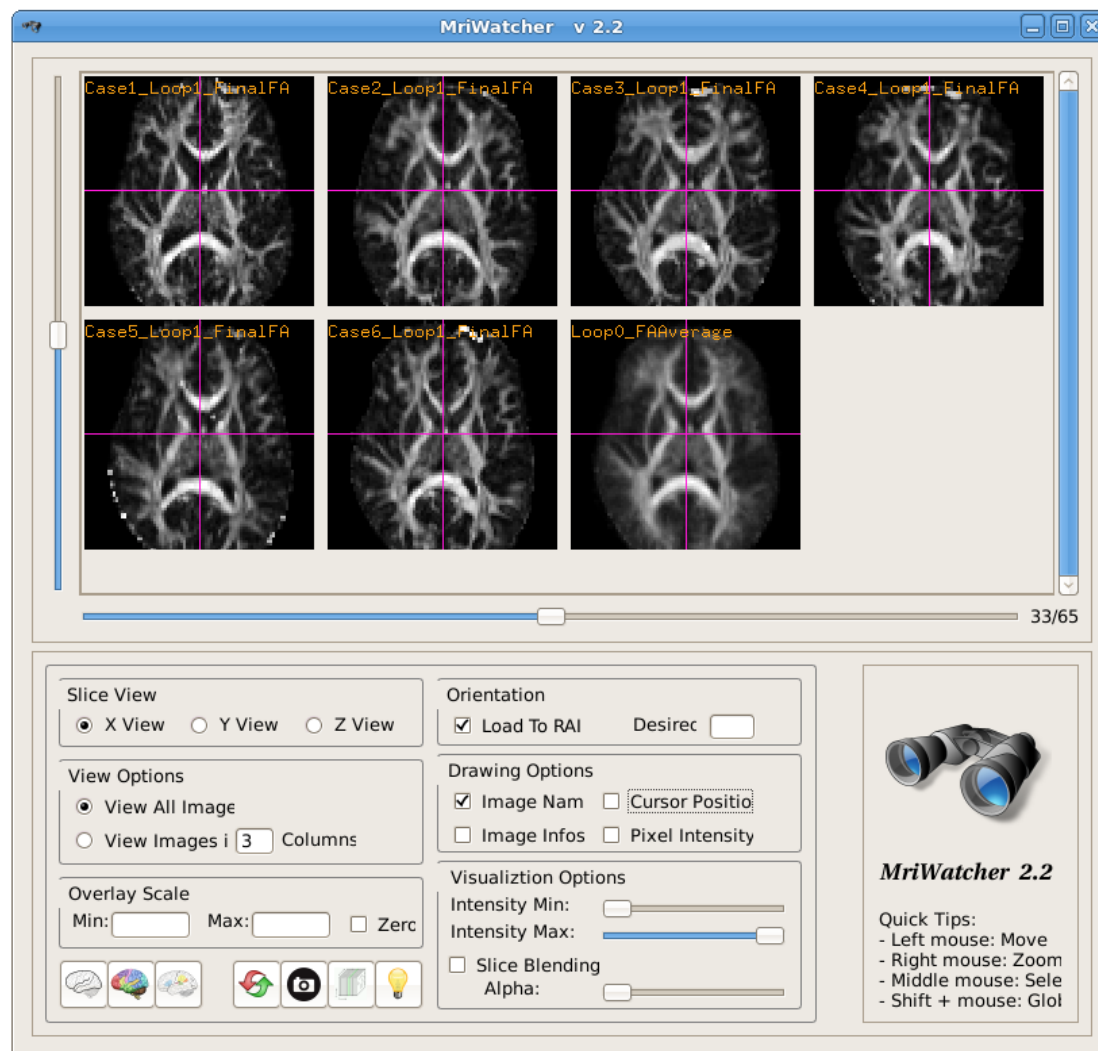
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- By pushing one of the QC buttons, you will run MriWatcher to see the images at different steps of the compute, and check if the results are good.



# Quality Control

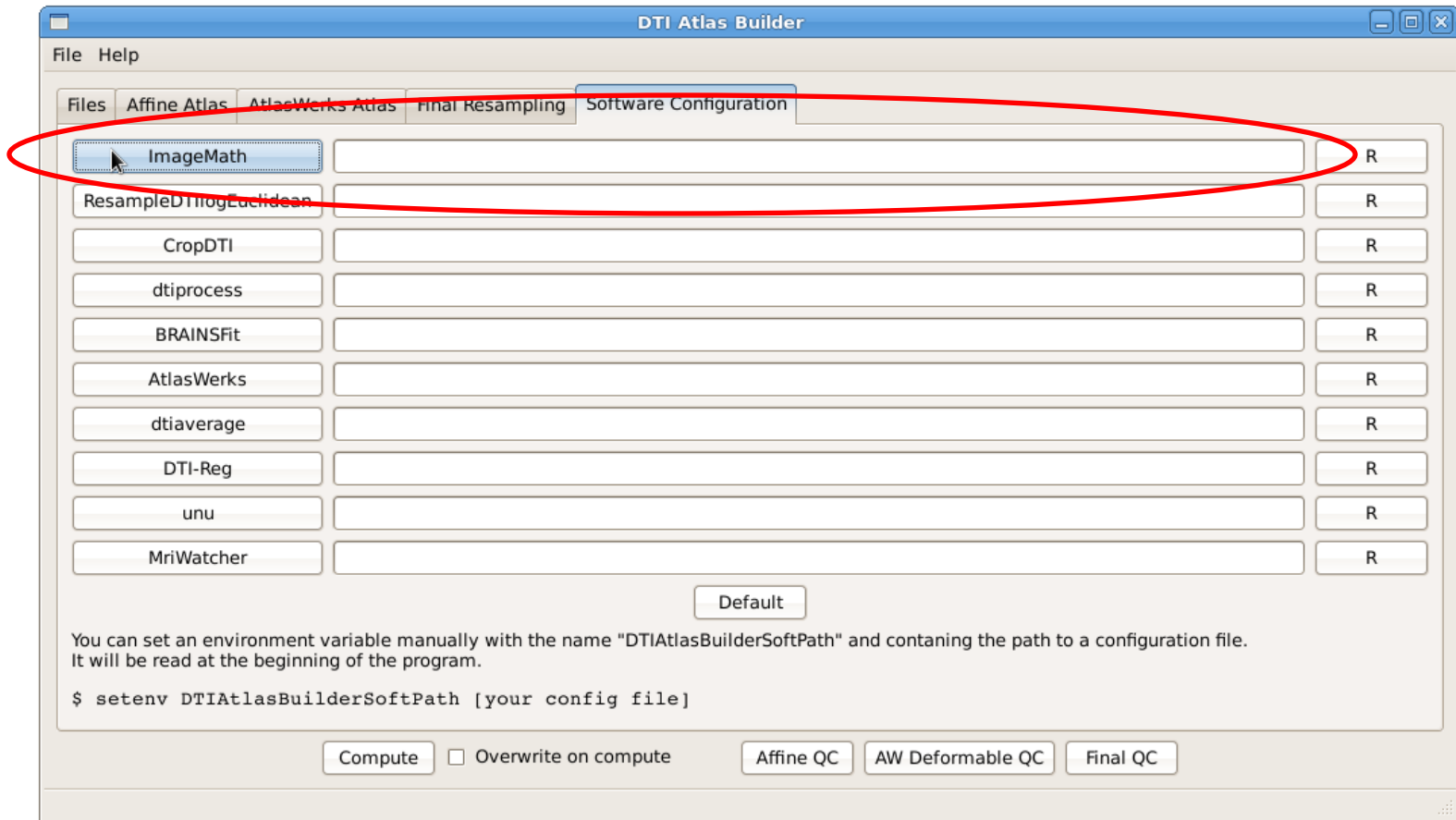
- Affine QC: Affine registered FAs and last affine average computed
- AW Deformable QC: AtlasWerks non linear registered FAs and AtlasWerks Atlas
- Final QC: Final DTI-Reg resampled FAs and final Atlas



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# Software Configuration

## Manual Configuration



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- If you have your own version of the programs or if you need to use a particular version of it, you can write the path manually or click the button to search it.

# Software Configuration

## Automatic Configuration

DTI Atlas Builder

File Help

Files Affine Atlas AtlasWerks Atlas Final Resampling Software Configuration

|                         |  |   |
|-------------------------|--|---|
| ImageMath               |  | R |
| ResampleDTIlogEuclidean |  | R |
| CropDTI                 |  | R |
| dtiprocess              |  | R |
| BRAINSFit               |  | R |
| AtlasWerks              |  | R |
| dtiaverage              |  | R |
| DTI-Reg                 |  | R |
| unu                     |  | R |
| MriWatcher              |  | R |

Default

Use the program paths given by the system

You can set an environment variable manually with the name "DTIAtlasBuilderSoftPath" and containing the path to a configuration file. It will be read at the beginning of the program.

```
$ setenv DTIAtlasBuilderSoftPath [your config file]
```

Compute ☐ Overwrite on compute Affine QC AW Deformable QC Final QC

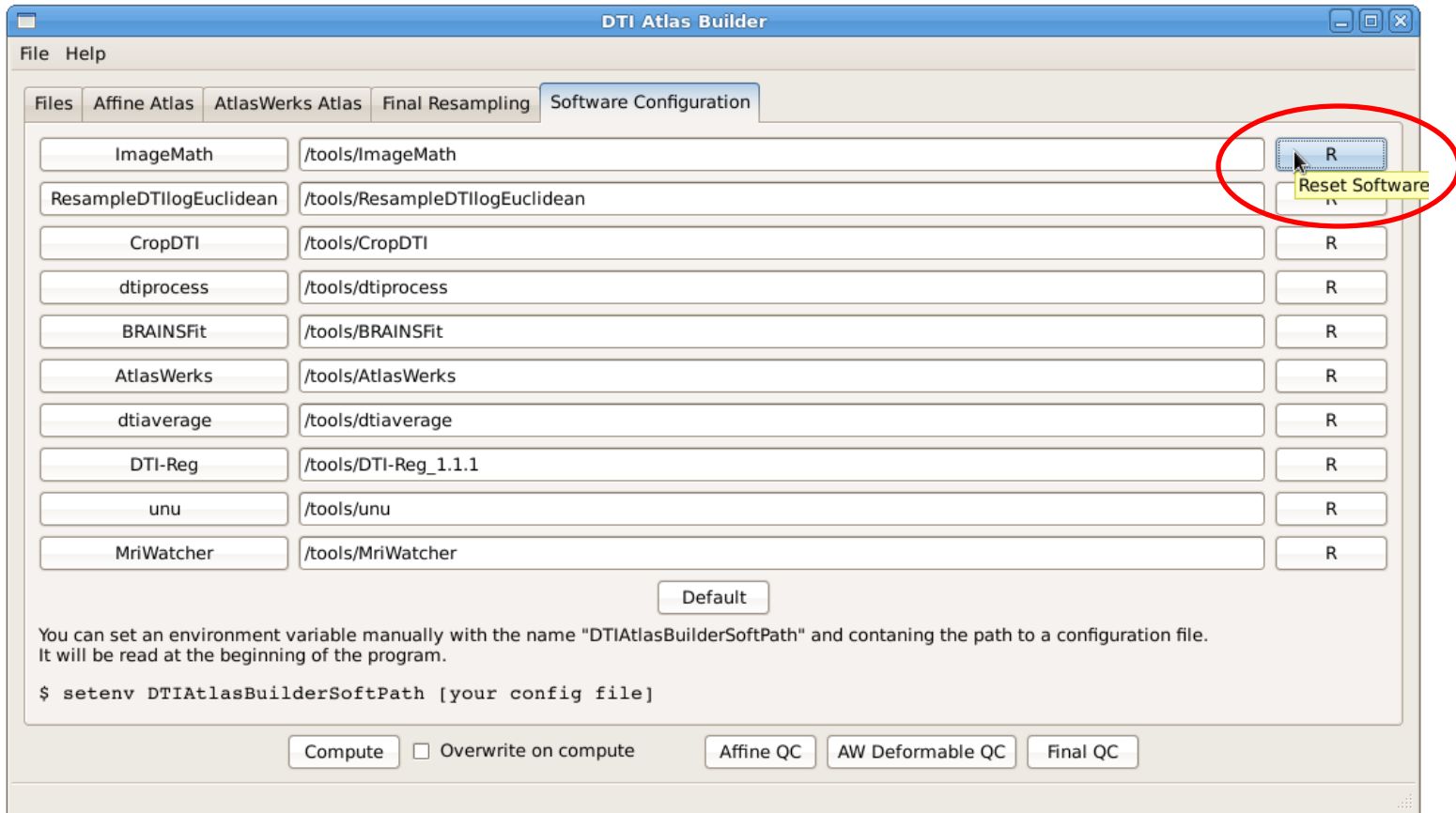


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- By clicking the "Default" button, the program will automatically search all the programs in the PATH, and tell you if some of them are missing.

# Software Configuration

## Automatic Configuration



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- If you want to reset the path for one or more programs, just push the "R" button and it will search the corresponding program in the PATH.

# Software Configuration

## Load and Save

- Save your configuration: In the « File » Menu, you can Save or Load a configuration file generated by the program.
- You can set an environment variable manually with the name `DTIAtlasBuilderSoftPath` and containing the path to a configuration file. It will be read at the beginning of the program to configure the softwares.



# Software Configuration

## AtlasWerks

- The version of AtlasWerks used in the program is a recent version that uses an XML file, written by the program, to set all the needed parameters. Be sure to have this version installed on your computer before using the program.



# Command Line

## Command Line Options

« DTIAtlasBuilder --help »:

- Load :
  - -d <std::string>, --dataset\_file <std::string> :  
CSV file containing the dataset
  - -p <std::string>, --parameter\_file <std::string> :  
Parameter file from this program
  - -c <std::string>, --configuration\_file <std::string> :  
Software configuration file
- Options:
  - --overwrite : If you want to overwrite on compute (default: 0)
  - --quiet : If you do not want any command line display (some programs with no quiet option called by this tool may display informations anyway) (default: 0)
  - --nogui : If you do not need the GUI (default: 0)



## No GUI mode

- In « No GUI » mode, you need to set the parameters by giving a parameter file in command line :

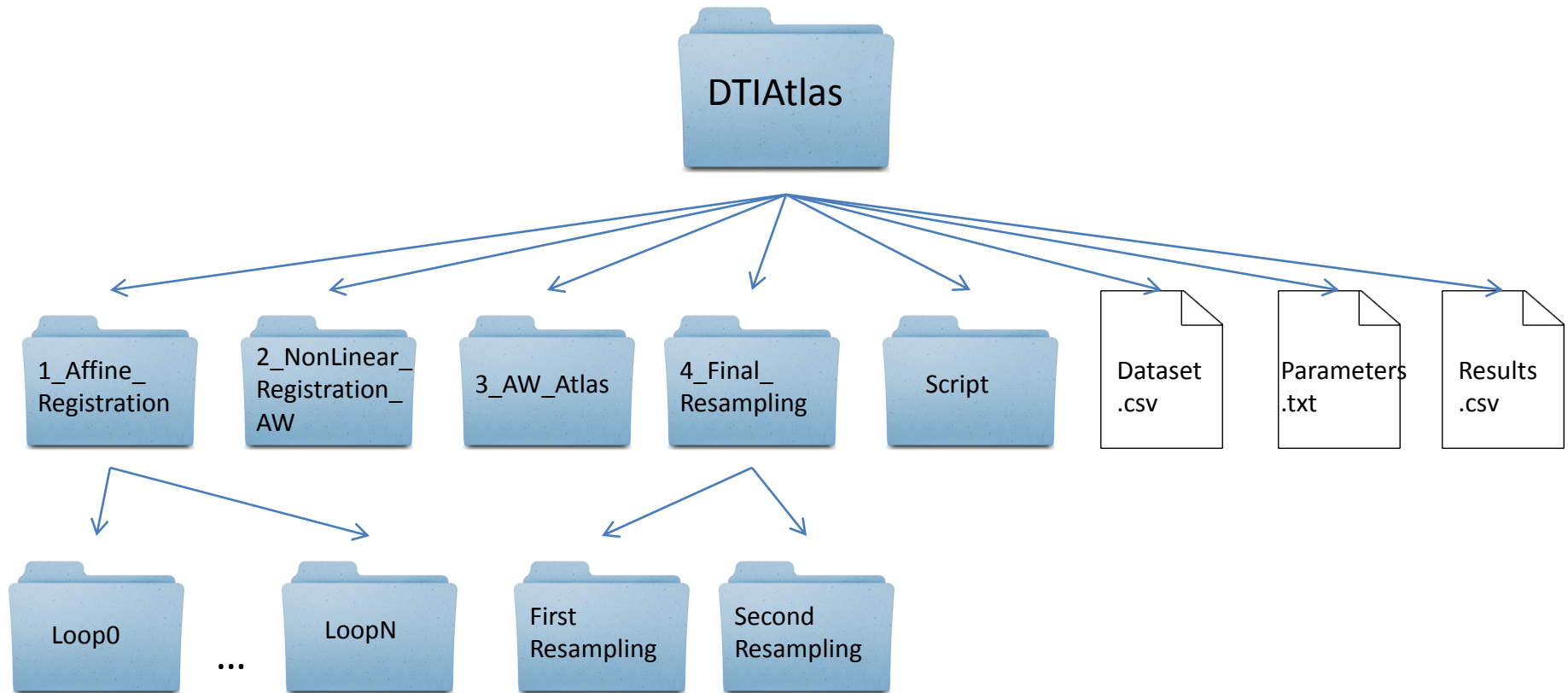
```
DTIAtlasBuilder --nogui -p /home/DTIParameters.txt
```

- The program will not display the GUI and will run automatically with the given parameters, as if you had pushed the « Compute » button.





# Data Organization



# Data Organization

- « 1\_Affine\_Registration » contains :
  - LoopX :
    - CaseX\_LoopX\_FA.nrrd
    - CaseX\_LoopX\_LinearTrans.txt
    - CaseX\_LoopX\_LinearTrans\_DTI.nrrd
    - CaseX\_LoopX\_LinearTrans\_FA.nrrd
    - CaseX\_LoopX\_NormFA.nrrd
    - LoopX\_FAAverage.nrrd
  - CaseX\_FA.nrrd
  - CaseX\_CroppedDTI.nrrd
- « 2\_NonLinear\_Registration\_AW » contains :
  - AtlasWerksParameters.xml
  - AverageImage.mhd
  - CaseX\_DeformationField.mhd
  - CaseX\_InverseDeformationField.mhd
  - CaseX\_NonLinearTrans\_FA.mhd
- « 3\_AW\_Atlas » contains :
  - CaseX\_AWDTI.nrrd
  - CaseX\_AWDTI\_float.nrrd
  - CaseX\_AWFA.nrrd
  - AWAtlasDTI.nrrd
  - AWAtlasDTI\_float.nrrd
  - AWAtlasFA.nrrd
  - + Color FA, MD, RD, AD
- « 4\_Final\_Resampling » contains :
  - Fisrt(Second)\_Resampling:
    - CaseX\_FA\_AffReg.txt
    - CaseX\_(Final)DeformedDTI.nrrd
    - CaseX\_(Final)DeformedDTI\_float.nrrd
    - (CaseX\_FinalDeformedFA.nrrd)
    - CaseX\_GlobalDeformationField.nrrd
  - FinalAtlasDTI.nrrd
  - FinalAtlasDTI\_float.nrrd
  - FinalAtlasFA.nrrd
  - + Color FA, MD, RD, AD
- « Script » contains :
  - DTIAtlasBuilder\_MainScript.script
  - DTIAtlasBuilder\_Preprocess.script
  - DTIAtlasBuilder\_AtlasBuilding.script



# DTIAtlasBuilder online

- GitHub: <http://github.com/adrienkaiser/DTIAtlasBuilder>

